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Document Title **CAL Process Specification for Assembly and Testing of Dual PIN Photodiode Assembly**		

GLAST LAT
Calorimeter Process Specification for
Assembly and Testing of Dual PIN Photodiode Assembly (PDA)

DOCUMENT APPROVAL

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CHANGE HISTORY LOG

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1 PURPOSE AND SCOPE

1.1 General

This document defines the soldering and staking procedures and acceptance criteria to be used for high reliability of hand soldering of the Dual PIN Photodiode (DPD) to wire conductors. The purpose of this document is to specify the detailed requirement of the Photodiode Assembly (PDA). This assembly consists of one tested flight Dual PIN Photodiode (DPD) with optical silicone window, four (4) different color flight wires, and two (2) non-flight test connectors. Figure 1 shows the completed Photodiode Assembly.

This specification covers the PDA during various phases of its use which include:

- Assembly (DPD, wires, staking, and nonflight connectors)
- Testing after assembly
- Storage
- Packaging and shipping

Appendix B shows the general flow of activities and details as they are described herein.

NRL will supply the DPD tested in vacuum-sealed bags, flight wire materials, nonflight test connector components, staking uralane 5753 LV A/B premixed, the fixtures for assembly as per figures 2, 3, 4, and 5, test stations for testing of the assembled PDA, ESD containers, desiccant, humidity indicator for packaging and shipping, and technical guidance for these tasks.

2 REFERENCE DOCUMENTS

2.1 Military

MIL-F-14256	Flux, Soldering, Liquid (Rosin Base)
QQ-S-571	Solder, Tin Alloy, Tin Lead Alloy and Lead Alloy
MIL-W-22759	Copper or Copper Alloy Fluoropolymer-Insulated Electrical Wire

2.2 NASA

NASA-STD-8739.1	NASA Technical Standard, Staking and Conformal Coating
NASA-STD-8739.3	NASA Technical Standard, Soldered Electrical Connections
NASA-STD-8739.7	NASA Technical Standard, Electrostatic Discharge Control

2.3 Other

ANSI/J-STD-002	Solderability Tests for Components Leads, Terminations, Lugs, Terminals, and Wires
ANSI/J-STD-006	Requirements for Electronic Grade Solder Alloys and Fluxed and Non-Fluxed Solid Solders for Electronic Soldering Applications
LAT-DS-00209-12	GLAST LAT Calorimeter Flight Dual PIN Photodiode Specification
MILL-MAX-851-	Non-Flight Connectors 99-002-10-002000

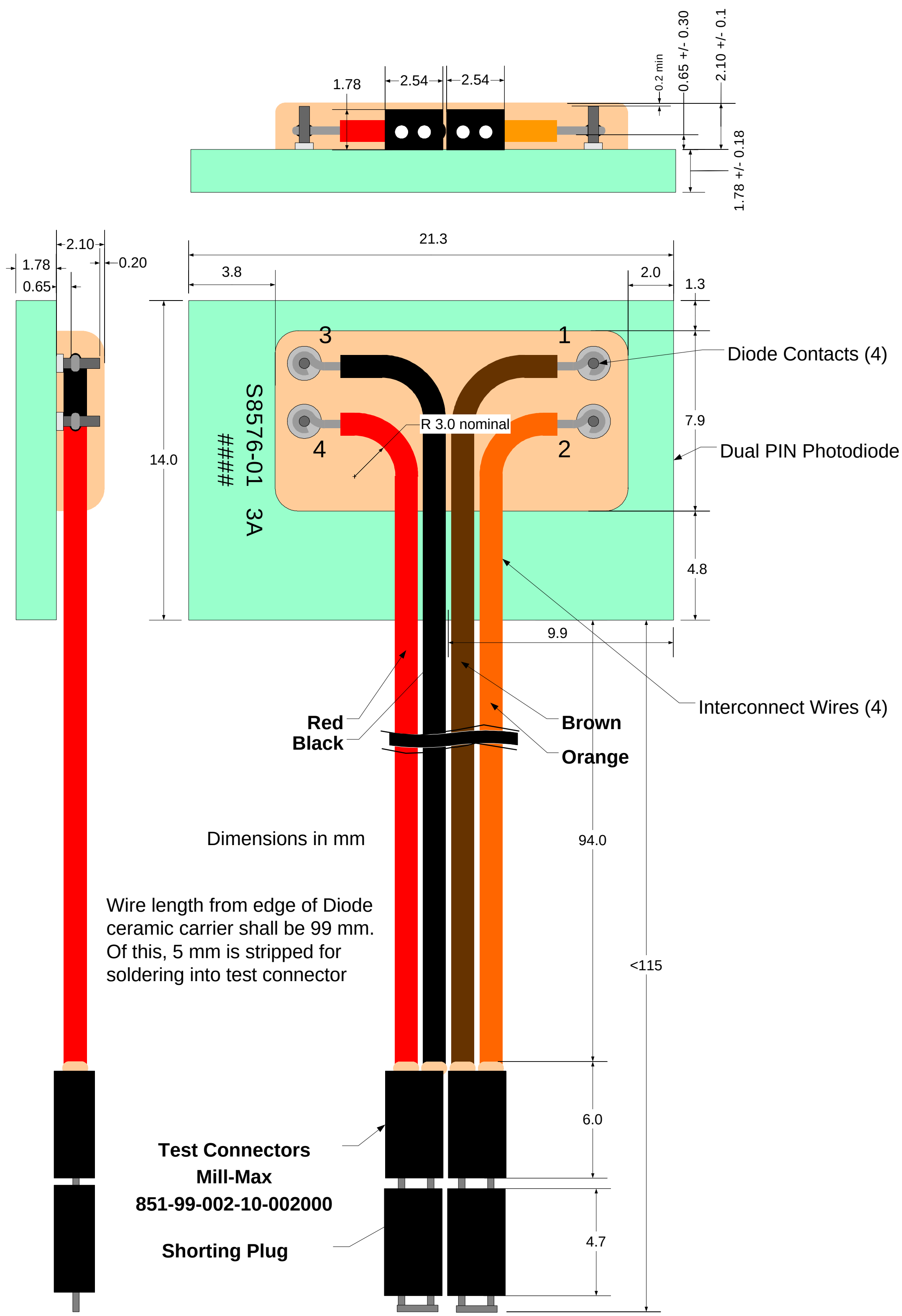


Figure 1. DPD Assembly Drawing

3 PROCEDURE

3.1 Prerequisites

3.1.1 Personnel Certification

All personnel engaging in fabrication, assembly and inspection of Dual PIN Photodiode (DPD) and wire cable conductor to which this procedure applies shall be qualified and certified for soldering and ESD functions to the relevant NASA standard.

3.1.2 Electrostatic Discharge Requirements

Electrostatic discharge (ESD) training and handling requirements shall be in accordance with NASA-STD-8739.7. All operations as per this procedure require ESD precautions and handling as per NASA-STD-8739.7 or equivalent approved procedures.

3.1.3 Environment

Soldering and staking operations shall be performed in an enclosed facility maintained at a slightly positive air pressure equivalent to class 100,000 with special precautions for handling the optical window of the DPD.

3.1.4 Temperature and Humidity

The temperature shall be maintained at 68 ± 9°F (20 ± 5°C) and the relative humidity shall not exceed 65%. When humidity decreases to a level of 30 percent or lower, electrostatic discharge sensitive devices and assemblies shall be protected using other controls, such as air ionizers or humidifiers. Temperature and humidity levels shall be monitored and recorded using a recorder during the assembly and testing of the PDA.

3.1.5 Workstation Cleanliness

Work areas and tools shall be maintained in a clean and orderly condition. There shall be no visible dirt, grime, grease, flux, or solder splatter, nor other contaminating foreign materials at any workstation. Eating, smoking or drinking in the work area is prohibited. Hand creams, ointments, perfumes, cosmetics and other materials unessential to the assembly operation are also prohibited at the workstation or in the work area.

3.1.6 Assembly

PDA assembly involves cutting the leads of the DPD as per figure 1, soldering the four (4) different color wires to the 4 leads of the DPD, bending the wires for stress relief prior to staking of the wire on the back of the DPD ceramic surface, curing, soldering of the two nonflight connectors, testing, assembly of shortening plugs, baking, and packaging prior to shipping to NRL.

Two nonflight connectors at the end of the wires are required for testing of the PDA after assembly and two nonflight shortening plugs are required to avoid damage due to ESD. These connectors and shortening plugs will be removed by NRL for pre-electronic module testing and for CDE insertion in the mechanical structure of the CAL module.

3.1.7 Lighting Requirements

Light intensity shall be a minimum of 100 foot-candles (1077 Lm/M^2) on the surface used for soldering or inspection. Supplemental lighting may be used to assist these operations.

3.1.8 Solder

Solder composition (Sn 63%, Pb 37%, eutectic solder), conforming to ANSI/J-STD-006, Requirements for Electronic Grade Solder Alloys and Fluxed and Non-Fluxed Solid Solders for Electronic Soldering Applications, shall be used.

3.1.9 Flux

Rosin based fluxes shall be only type RMA (mildly activated). Liquid flux used in conjunction with core flux shall be of the same manufacturers type. Liquid flux used shall be within the shelf life expiration date.

3.2 Tooling, Equipment, and Fixtures

3.2.1 Clinching Tools

Clinching tools or clinching devices shall be of such a design and manufacture so that they will not cause damage to assembly DPD leads.

3.2.2 Lead Cutting Tools

Tools used to cut leads of DPDs and wire components shall not damage the leads and wires or impart any stress (shock) to the DPD body or seal. Cutters or holding fixtures to absorb the shock shall be used. Snip the surplus DPD leads length off first, to make the solder joint more accessible and avoid applying a mechanical shock to the solder joint.

3.2.3 Holding Devices and Fixtures

Devices and fixtures that hold, handle or come in contact with DPD, wire and the assembly shall not damage, deform or degrade the DPD, wire, and/or the assembly. Only NRL supplied or approved fixtures and tools shall be used.

3.2.4 Brushes

Brushes used for cleaning or applying solvents shall have medium stiff natural bristles.

3.2.5 Tweezers

Tweezers used, if required for the holding of DPD, shall be made of ESD approved, nonmetallic, smooth jawed type to prevent tool marks. Material type used shall be ESD Safe. Size will be optional based upon intended use.

3.2.6 Soldering Equipment

Soldering irons, soldering machines and systems and associated process equipment (including fluxers, preheaters, solder pots, cleaning system and cleanliness test equipment) shall be of a type that does not compromise functional integrity by injecting electrical energy to the item(s) being soldered.

3.2.7 Soldering Irons

Soldering irons shall be of the temperature-controlled type, controllable within ±10°F (+5.5°C) of the pre-selected idling temperature. The size and shape of the soldering iron and tip shall permit soldering with the maximum ease and control without causing damage to adjacent areas or connections. The soldering iron or resistance-heating element shall heat the connection area rapidly and maintain proper soldering temperature at the connection throughout the soldering operation. Three-wire cords and tip grounding to prevent potential greater than 2 mV RMS at the tip shall be used when soldering. The soldering iron shall be of such design as to provide zero voltage switching. Transformer type soldering guns shall not be used. Soldering equipment shall be calibrated and verified for temperature stability, tip voltage and tip resistance semiannually in accordance with Appendix C using a solder system tester. Calibration records traceable to each solder iron by model and serial number shall be maintained. A calibration sticker shall be affixed to each solder iron.

3.2.8 Soldering Iron Tips

The soldering iron tips or resistance soldering element shall be sized to the operations involved. Soldering iron tips shall be made of commercially pure copper, tellurium copper or lead copper and shall be plated or coated with another metal that prevents degradation of the tip in molten solder. Soldering iron tips must be kept clean and tinned adequately to prevent oxidation while idling. Tips must be loosened, rotated and re-tightened daily to assure consistent heat transfer from iron to tip. Tips must be replaced when oxidized or pitted.

3.2.9 Magnification Aids

Magnification aids for inspection of solder connections shall be 4x to l0x. For inspection of solder connections, magnification aids of a type that permits simultaneous viewing with both eyes shall be used. Additional magnifications may be used as necessary to resolve suspected anomalies or defects.

3.2.10 Light Sources

Light sources shall provide illumination to the solder connection area such that no shadows fall on the connection except those caused by the connection itself or the leads entering the connection.

3.2.11 Handling

DPD leads and wire cable surfaces to be soldered shall not be handled with bare hands. Wire shall be handled by the insulation or protective devices such as finger cots, ESD gloves or special tooling.

3.2.12 Cleanliness

Any unit that has been subjected to a soldering operation and will subsequently be stored prior to further processing must be thoroughly cleaned using 100% ethyl alcohol and a clean room swab as defined herein. Never touch the optical window during lead cutting, soldering, staking, baking, and other operations. NRL supplied fixtures shall be used and the ceramic surfaces shall be sealed using acrylic adhesive Kapton tape if required, to avoid contamination entering through the DPD clearance to the optical surface.

3.2.13 Mechanical Wire Stripper

Mechanical wire strippers used to remove insulation from stranded or solid conductor wires may be of the hand operated or automatic high volume machine type. Hand operated strippers shall be of a fixed die configuration. Automatic high volume machine strippers shall be of a type using either fixed dies, dies adjustable to calibrated stops, or roller cutters adjustable to calibrated stops. Dies, whether adjustable or fixed, shall be properly maintained to assure consistently sharp and even cuts without damage to the wires or unstripped insulation.

3.2.14 Wire Stress Relief

Stress relief shall be incorporated during soldering to provide freedom of movement of DPD leads and wire as defined in NASA-STD-8739.3. Freedom of movement shall be sufficient to prevent detrimental stresses to the solder connection due to expansion or contraction caused by thermal variations or mechanical excursions. (This will not be an issue. Since we are staking wires to avoid damage due to handling.)

3.3 Dual PIN Photodiode

The Dual PIN Photodiode supplied by NRL complies with the specifications and tolerances in the document "Calorimeter Flight Dual PIN Photodiode Specification", LAT-DS-00209-12. The DPD drawing is attached in appendix A. The DPDs will have an optical silicone window. It is soft and attracts dust; precautions have to be taken for its protection as defined herein. The leads of the DPD are pre-tinned but shall be cut to the length using NRL supplied fixture as per figure 1 prior to soldering.

3.4 Wires

The wires supplied by NRL shall be space qualified. They shall meet the requirements of MIL-W-22759 and shall be AWG 28 – 7 strands. The wires shall allow a very short bending with a minimum radius of 3 mm. One end of the wire shall be soldered to the DPD and the other end to the nonflight connector. For the assembly and tests, the wires shall be of length as specified in figure 1, from the edge of the DPD. All the wires shall be cut to the same length from the DPD, prior to soldering of the nonflight connector. It is suggested that all fabrication allowances shall be added prior to soldering of wires to the DPD. Special care shall be taken while handling these wires since the insulation and wire strand are very thin.

Each wire shall be of a different color with the following color configuration and attachment of the wires:

Contact (Pin)	Wire Color	Definition
1	Brown	Cathode A
2	Orange	Anode A
3	Black	Cathode B
4	Red	Anode B

The insulation between wires shall be greater than 1 GOhms (under 100V). The wires shall accept at least a Voltage of 100V.

3.5 Connector and Shortening Plugs

Two non-flight connectors (Mill-Max 851-99-002-10-002000) supplied by NRL shall be assembled and soldered as per NASA-STD-8739.3, to the ends of the wire. After soldering, the wires at the end of the connector must be staked. The two leads of the connector/shortening plugs should be shortened and soldered prior to assembly to the connector after final testing of the PDAs and prior to shipping.

3.6 Soldering Procedure

The final key to a successful solder joint is to apply an appropriate amount of solder. Too much solder is an unnecessary waste and may cause damage. Too little and it may not support the DPD properly, or may not fully form a working joint. How much to apply, only really comes with practice.

Soldering of the wires shall be performed using NRL supplied fixtures as defined in paragraph 4.0.

3.6.1 Soldering Iron Preparation

1) Select a soldering iron with the appropriate temperature for the connection or tinning to be performed.
2) Check tools daily for proper condition, operation, performance, and cleanliness.
3) Prior to and periodically during use, the tip shall be checked for:
    a. Proper insertion
    b. Tight attachment
    c. Cleanliness
    d. No oxidation scale between the tip and heat element
    e. Proper grounding
    f. Proper tip size relative to the work involved.
    g. Tip temperature
4) After selecting the proper iron, allow five (5) minutes for warm-up.
5) Apply RMA flux to soldering tip, apply sufficient solder to cover the tip and wipe on the damp sponge.

6) Repeat, as necessary, to obtain clean, shiny surface on the tip.

3.6.2 Wire Stripping

1) Wire Preparation – Cut approximately 6” length of wire using side cutters.
2) Mechanical Wire Stripping – With jaws open, place the wire in the appropriate die corresponding to the wire size being stripped. Squeeze the handles to partially cut and separate the insulation only a short distance. Slightly release the pressure on the handles. Remove the wire, close the strippers, and set the stripper down.
   - Mechanical strippers must not be operator adjustable, must be in calibration, and must not damage the wire or unstripped insulation.
3) Remove the Insulation – Holding the wire in one hand, grasp the separated portion of the insulation with the thumb and forefinger of the other hand. Remove this portion with a smooth, even motion in the direction of the lay of the wire.
   - If disturbed, the lay of the wire strands shall be restored as nearly as possible to the original.
4) Inspection – Inspect under 4x to 10x magnification.
   - Conductors and parts rejections include nicks, cuts, and crushing or charring of the insulation (slight discoloration from thermal stripping is acceptable).
   - After insulation removal, the conductor shall not be cut, nicked, stretched, or scraped leads or wires exposing base metal (except smooth impression marks resulting from bending tool holding forces).

3.6.3 Tinning of Wires Using Solder Pot

1) Clean the lay of the wire strands.
2) Check solder pot temperature – Check the temperature of the solder pot by immersing a calibrated thermometer approximately 2.5cm (1 in.) into the solder at the center of the pot. The reading should be 260°C ± 5.5°C (500°F ± 10°F).
3) Add Flux – Place type R or RMA flux on the end of the stripped wire to be tinned.
4) Remove Dross – Remove the dross from the solder surface with an approved tool.
5) Tinning – Dip the prepared wire into the molten solder to within 0.5 mm (0.020 in.) of the insulation. Slowly rotate the wire for no more than 5 seconds, and then slowly remove the wire from the solder.

6) Clean the wire – Clean the flux from the tinned portion of the wire with an acid brush; use the approved solvent and shopwipe.

7) Inspection – Inspect the tinned wire under 4x to 10x magnification.
   - Conductor tinning personnel shall ensure that the tinned surfaces exhibit 100% coverage. Wire strands shall be distinguishable.

8) The appearance of the solder joint surface shall be smooth, nonporous, undisturbed, and shall have a finish that may vary from satin to bright depending on the type of solder used.

3.6.4 Cutting of the DPD leads to the desired length for soldering.

As the DPDs will be supplied tinned hence, no retinning is required prior to cutting the DPD leads using the fixture supplied by NRL as defined in paragraph 4.0. Cut to the desired length as defined in Figure 1 using the proper tools prior to soldering.

3.6.5 Photodiode and Wire Cable Soldering

1) Prepare the connections

   a. Clean the wire and DPD leads in the fixture with an acid brush, using the ethyl alcohol and lint free swabs.

   b. Position the DPD in the approved fixture. To bend the wire around the DPD lead, grasp the end of the stripped and tinned wire with a pair of pliers. Place the wire on the lead of the DPD. Holding the wire in place with your fingers, move the pliers to wrap the wire tightly around the lead, being aware of the proper insulation clearance.

   c. Remove the wire from the DPD lead. Using wire cutters, flush cut the bent wire so that it will only make contact with the lead from 180° minimum (1/2 turn) to less than 360° maximum.

   d. Hold the cut wire against the terminal to check the wrap dimension. The wire shall contact the DPD lead for the full turn for which it is cut. Recut the end of the wire as necessary.

   e. The insulation shall not be imbedded in the solder joint, and shall terminate less than 2 wire diameters from the solder joint.

2) Position the Wire – Hold the wire during soldering in the fixture. The wire is mounted on the DPD lead and shall stay in contact with the diameter. Adjust the wire for the proper tension, centering, and position.

3) Clean the Connection – Clean the connection with a soft brush, using ethyl alcohol and lint free swabs. Do not disturb the position of the wire.

4) Cut the Solder – Cut the end of the solder to expose the flux in the core of the solder. Wipe the solder with a shopwipe and solvent to remove any contaminants.
5) Clean the Soldering Iron – Prepare the iron by wiping the tip with a dry shopwipe. Lightly wipe the tip on a slightly moist sponge to remove the oxides.
6) Position the Iron – Place a clean soldering iron tip against the DPD lead so as to contact both the wire and the DPD lead at the same time.
7) Apply Solder – Apply a small amount of solder to the junction where the wire, DPD lead, and iron meet to form a thermal (solder) bridge. Now touch the solder to the end of the cut wire to cover the exposed copper. Add solder as needed to complete the soldered connection. Remove the solder; remove the iron.
8) Tin the Iron – Tin the iron tip, while the connection is cooling at room temperature. A small amount of solder should remain on the tip. Return the iron to the holder.
9) Clean the connection – Clean the flux from the soldered connection with an acid brush, using the ethyl alcohol and shopwipe.
10) Inspect the Connection – Inspect the solder joint under 4x to 10x magnification to the specified requirements:
    a. Wire conductor bend shall be wrapped more than ½ (180°) but less the 360°.
    b. All tinned wire shall be confined to DPD lead.
    c. Wires shall be maintained in contact with the DPD lead for full curvature of the wrap and the wire ends shall not extend beyond the base of the DPD.
    d. The joint shall be free of flux residue and other contaminants.
    e. The surface shall be smooth and nonporous.
    f. It shall be undisturbed and have a finish that may vary from satin too bright.
    g. The solder shall wet all elements of the connection.
    h. The solder shall fillet between connection elements over the complete periphery of the connection.
    i. The lead contour shall be visible.
    j. Proper insulation clearance, not embedded in the solder joint.
11) Using the above steps, solder all four leads of the DPD using wire with different color insulation as defined in paragraph 3.4.

3.6.6 Connector Soldering after Wire Cable Soldering to DPD

The other end of the wires not connected to the DPD solder joint shall be cut to 99 mm ±

5 mm from the edge of the DPD as indicated in Figure 1. All wire shall end at the same distance from the DPD. The wires shall be stripped exposing 5 mm for tinning. The ends shall be tinned as defined herein prior to soldering as per NASA-STD-8739.3.

The two non-flight connectors, Mill-Max 851-99-002-10-002000, as defined herein shall be cleaned using ethyl alcohol prior to soldering. Solder the wire to the connector as per NASA-STD-8739.3. During this assembly, the PDA shall not be removed from the fixtures. The soldered connections shall be staked with uralene, as defined herein, to cover the exposed wire and solder joints on the nonflight connector.

3.6.7 Preloading

During the soldering operation, DPD retainment must be consistent with the principle that no preloading of the leads/solder joint is allowed. There shall be no relative motion between DPD leads and wire cable termination areas during solder application and solidification. The soldering operation must not result in the holding of DPD leads against normal spring-back forces or deforming wire cable such that resulting solder joints contain residual stresses.

3.6.8 Heat Damage

Due to the small size of wire cable, proper heat dissipation is essential. Excessive heat can damage wire cable. For this reason, soldering iron tip temperature shall not exceed 650°F (343°C). Size of the tip (heat capacity) must be selected so that fairly rapid heating is accomplished and the solder connection is made in less than five (5) seconds.

3.6.9 Flux Application

The use of external flux should be avoided. However, if external flux is required it must be applied to the surfaces to be joined prior to the application of heat. The use of excess flux should be avoided. When an external liquid flux is used in conjunction with cored flux solders, the fluxes shall be chemically compatible.

3.6.10 Solder Application

A well-tinned tip shall be applied to the joint and solder introduced at the junction of the tip and the connection for maximum heat transfer. After applying heat and achieving heat transfer, the solder should be applied to the joint and not the soldering iron tip.

The joint should be heated with the tip for just the right amount of time - during which a short length of solder is applied to the joint. Do not use the iron to carry molten solder over to the joint. Excessive time will damage the component and perhaps the wire cable. Heat the joint with the tip of the iron, then continue heating while applying solder, then remove the iron and allow the joint to cool. This should take only a few seconds (no more than 5 seconds), with experience.

NOTE: Timing – it is essential that the total time-temperature cycle is enough to assure a properly wet joint, and small enough to assure that the joint is not overheated, or that heat damage to the wire cable conductor has occurred.

3.6.11 Cooling

Forced cooling shall not be used to cool solder joints. Connections shall only be cooled at room temperature.

3.6.12 Cleanliness

Without exception, all DPD leads and wires, including the iron tip itself, must be clean and free from contamination. It is an absolute necessity to ensure that the DPDs and wire are free from grease, oxidation and other contamination. After preparing the surfaces, avoid touching the DPDs leads and wire leads afterwards if at all possible. Touching the DPD's optical surface may damage the DPD as well as the wirebonds underneath the optical surface. Optical silicone resin is soft and sensitive to external forces.

Dirty surfaces may encourage the operators to want to apply more heat in an attempt to "force the solder to take". This will often do more harm than good because it may not be possible to burn off any contaminants anyway, and the DPD may be overheated. In the case of DPDs, temperature is quite critical and they may be harmed by applying such excessive heat.

Before using the iron to make a joint, it should be "tinned" (coated with solder) by applying a few millimeters of solder, then wiped on a damp sponge preparing it for use: you should always do this immediately with a new bit. Always re-apply a very small amount of solder again, mainly to improve the thermal contact between the iron and the joint, so that the solder flows quickly and easily.

Normal electronics grade solder is usually 67% lead - 33% tin, and it contains flux, which helps the molten solder to flow more easily over the joint. Flux removes oxides, which arise during heating, and is seen as a brown fluid bubbling away on the joint.

3.6.12.1 Cleanliness and Reliability

a. Cleaning is required during and after processing DPD assemblies. DPD assemblies shall be cleaned within a time frame of 10 minutes for appropriate removal of flux contaminants after soldering.

b. Due to tight spacing and contamination sensitivity, use clean room grade lint-free swabs to clean the solder joint and underneath the solder joints within 10 minutes of soldering.

c. After cleaning the assemblies, the solder joints must be verified to ensure that the assemblies are free of dirt, lint, solder splash, dross, flex residue, and other ionic contamination by visual examination.

d. Ultrasonic cleaning is not permissible on DPDs, since the mechanical and electrical performance of the DPDs and wire cable conductors can be damaged.

e. Do not allow cleaning solvent to flow towards the optical window. Use acrylic adhesive Kapton tape to seal the edges of the ceramic surface while soldering or cleaning is performed. Long term exposure for more than 30 minutes of these cleaning solvents may effect the optical properties of the DPD.

f. Inspect the DPD assembly for solder joint, cleanliness, and any other damage and record all discrepancies.

3.7 Role of the Operator

The operator has a definite effect on the manual soldering process. The operator controls the factors during soldering that determine how much of the soldering iron's heat finally goes to the connection. Besides the soldering iron configuration and the shape of the iron's tip, the operator also affects the flow of heat from the tip to the connection. The operator can vary the iron's position and the time on the connection, and pressure of the tool against the pad and DPD lead and wire cable connection. When the tip of the iron contacts the solder connection, the tip temperature decreases as thermal energy transfers from the tip to the connection. The ability of the soldering iron to maintain a consistent soldering temperature from connection to connection depends on the iron's overall ability to transfer heat as well as the operator's ability to repeat proper technique.

Two easily measured indicators in the soldering process that can determine the reliability of the solder connection are the soldering iron's tip temperature and the solder's wetting characteristics. The tip's temperature during the soldering process is an indicator of the amount of heat being transferred from the tip to the connection. The optimum rate of heat transfer occurs if the soldering iron tip temperature remains constant during the soldering process. Another indicator for determining reliability is the solder's wetting action with the DPD lead and wire conductor preparation. As operators transfer heat to the connection, this wetting characteristic can be seen visually. If the molten solder quickly wicks up the sides of the component on contact, the wetting characteristic is considered good. If the operator sees the solder is flowing or spreading quickly through or along the surface of the wire cable conductor assembly, the wetting is also characterized as good.

3.8 Solder Rework

Rework of soldered connections shall be documented prior to any rework and NRL shall be informed. Rework of soldered DPDassembly shall be performed in accordance with the soldering requirements of this procedure. Repairs are not permitted.

3.9 Wire Cable Staking

3.9.1 Preparation of Wire Cable Routing for Staking

1) Route the wire cables without stressing the solder joint in the staking fixture as defined in paragraph 4.0 and as defined in Figure 1.

2) During routing the wire cable, the insulation of the wire should not be damaged. No metallic tools shall be used to route the four wires in the fixtures.

3) Maintain the proper stress relief on the wires during staking, parallel to the ceramic without overlapping wires on the ceramic surface. Solder joints and tools should be cleaned prior to staking because contamination will affect the leakage current.

3.9.2 Staking Material and Facility Requirements

1) The staking area shall have a controlled environment that limits the entry of contamination. The temperature and humidity of this area shall be monitored and maintained at 75 °F ± 9°F (25 °C ± 5°C) and relative humidity not to exceed 65%.
2) Urethene (uralane 5753 LV A/B with 7% CABOSIL premixed from Appli-Tech Inc., MA) shall be used for staking application and must meet the following outgassing criteria:
    a. The percentage of collectable volatile condensable material (CVCM) for the substance must be less than 0.1%.
    b. The total mass loss (TML) for the substance must be less than 1% and must be approved by NASA.

    These materials shall be stored in accordance with the manufacturers specification with cold storage. This is to ensure that the stated shelf life and use of material is not compromised. NRL will supply staking material.
3) Staking material storage shall be controlled by shelf life stickers attached to each material container. Staking material shall not be used if the shelf life has expired. The material shelf life shall be as stated by the manufacturer and in accordance with the manufacturer's specifications governing the usable life of the product.
4) Records of manufacturing date, lot number, receiving date, and manufacturer's certification of compliance of each material shipment shall be maintained on each traveler for the assembly of PDAs.
5) Material containers shall be marked in accordance with the following:
    a. Manufacturer's identification.
    b. Manufacturer's product designation.
    c. Batch number (if applicable).
    d. Storage temperature range (if applicable).
    e. Expiration date of guaranteed product life or use.
    f. Caution notes (where applicable).
6) Contact with bare hands should be avoided. ESD gloves or finger cots shall not generate a static charge.
7) A record of each mix batch date as supplied by the material supplier.
8) A witness sample shall be maintained for each lot on the traveler. The witness sample shall be processed at the same time and under the same conditions as the staking of the PDA assembly.

3.9.3 Staking

The main purpose for staking is to protect and support the wire cables, after forming, that may be damaged during bonding, handling, or vibration. Staking should also be applied to nonflight connector at the solder joint.

1) The staking material shall be applied to the DPD assembly ceramic surface and solder joint areas specified in the Figure 1. This material shall adhere to all surfaces to be joined. An NRL supplied dedicated mold as defined in paragraph 4.0 shall be used to perform this operation.
2) Before any staking application processing can begin, tools, assemblies, and working surfaces must be properly cleaned. Ethyl alcohol must be used and correct cleaning procedures for substrates must be followed, or else reliable adhesion will be compromised. All surface must be free from solder flux and other ionic, oily, or particulate contaminants. Any trapped contaminants will interfere with the performance on the staking application and will degrade the function of the DPD assembly. After cleaning, the DPD assembly shall be thoroughly air dried to remove all residual solvents and moisture prior to staking. The DPD assemblies to be processed shall be kept clean and dry until processing, with the staking material, is initiated. The effectiveness of cleaning will depend on the proper execution of the approved cleaning procedure.
3) Caution must be taken to assure that:
   a. The staking compound does not negate stress relief of wire cable and solder joints, or mechanically compromise the reliability of the DPD assembly.
   b. Staking material shall be free from contamination.
   c. Staking material shall not be applied until all of the cleaning solvent has evaporated.
   d. Staking shall be bubble free around the solder joint and wires.
4) The staking material shall be allowed to cure in accordance with the cure schedule specified for the material by the manufacturer. A tack free cure can usually be expected in a minimum of 24 hours at room temperature. A complete cure can be achieved by curing 1 hour at room temperature and 1 hour at 85°C in the clean oven. Do not remove the fixtures from the oven while they are hot. All precautions should be taken when removing the fixtures from the oven to avoid damage.
5) Acceptance Criteria for Staking
   a. The staking material shall adhere to the substrates’ ceramic surface.
   b. The staking material shall be free from contamination.
   c. Wire and solder joints shall be staked as per Figure 1.

d. The staking material shall be tack free when cured.

e. Staking height, width, and length must be as defined in figure 1.

f. Tolerances on the thickness are ± 0.1mm.

g. Minimum staking thickness over the soldered leads shall be 0.2 mm.

h. The wires in the staking shall be parallel to the DPD ceramic backside and embedded in the staking material without overlapping.

i. The ID number on the DPD ceramic surface shall not be covered with staking.

3.10 Electrical Test of DPD Assembly

All DPD assemblies, shall be removed from the staking fixtures and shall be visually examined and cleaned prior to testing. Testing shall be performed by an NRL designated representative after visual examination using NRL supplied test equipment for dark current and capacitance as defined below. Data shall be recorded on the traveler/work order or a specially designed database for each type.

PIN A (Small diode)

Parameter	Symbol	Condition	Min.	Type	Max.	Unit	Sampling
Dark Current	I_D	V_R = 70 V	0.2	1.0	3.0	nA	100%

PIN B (Large diode)

Parameter	Symbol	Condition	Min.	Type	Max.	Unit	Sampling
Dark Current	I_D	V_R = 70 V	0.5	2.5	7.5	nA	100%

3.11 Cleaning of PDAs and Inspection

Care shall be exercised not to damage the PDAs. Avoid touching the optical windows. All PDAs shall be examined for dimensions and contamination. If required, the optical surface of the PDA should be cleaned using a clean room swab and ethyl alcohol. The clean room swab should gently touch the surface of the optical window without pressing the soft silicon resin. Other surfaces and wires should be cleaned to remove all contamination prior to baking.

Inspection records shall be maintained on the PDA’s travelers.

3.12 NRL Source Inspection and Access to Facilities

PDA samples shall be inspected for solder joint and staking dimensions and cleanliness prior to packaging as per this specification. NRL shall have access to facilities during manufacturing, inspection, and testing.

3.13 PDA Packaging and Shipping

The PDAs shall be packaged in NRL supplied ESD containers and vacuum bagged.

PDA shall be packed as defined herein and in dedicated ESD shipping trays to prevent any stress and damage to the optical silicone resin and on the external wire and leads during the transportation and storage.

The following documents will be sent along with the shipment. Delivery documents shall describe the following:

- Total quantity of delivered PDAs along with travelers
- Documentation listed herein.

3.14 Storage

The DPD as well as the PDA shall be stored in a controlled environment of humidity and cleanliness.

3.15 General Cleanliness Requirement

The work shall be done in a clean area.

- The DPD optical silicone resin attracts the dust and a great care shall be taken while cleaning the optical window using clean room swab and ethyl alcohol.
- All the work shall be done in a clean area equivalent to a class 100,000
- During assembly the DPD window shall be protected from any pollution or dust deposition.
- Handling of both DPD and PDA shall be done with powder-free non-latex gloves.

If required, all the dust on the DPD window shall be cleaned using only ethyl alcohol with a clean room lint free swab using gentle strokes.

3.16 Rework

Every rework shall produce a non-conformance report. More than 1% of rework will stop the production and the affected processes will be reviewed.

3.17 PDA Qualification

Ten (10) PDAs from the first lot of flight PDAs assembled as per this specification, will be thermal cycled by NRL from -30°C to +80°C for 100 cycles. After thermal cycling, visual examination and electrical verification should not show any degradation.

4 Soldering and Staking Tooling

The Naval Research Laboratory shall provide tooling to support soldering and staking operations for the manufacture of PIN diode assemblies. Several copies of the tooling shall be provided to support the specified manufacturing rate of the PIN diode assemblies. The tooling concept is shown in Figure 2 through Figure 7.

The tooling consists of a base plate and several masks, which are specific for each assembly operation. Individual PIN diodes are supported on a base plate throughout the assembly process. The PIN diode is retained in a machined pocket within the base plate. The optical face of the diode is supported on a spring-loaded aluminum support surface, which pre-loads the PIN diode against the appropriate mask used for each assembly task. Four thumb screws secure each mask to the base plate. The machined recess in the base plate properly controls the alignment of the masks with the diodes.

Three sets of masks are provided for the operations:

1) **Lead Cutting Mask:** The lead cutting mask is used to cut the PIN diode leads to the correct length required for the assembly (1.8 ± 0.1 mm). When the PIN diodes are received from the manufacturer, the original length of the leads is 9 mm. In order to cut the leads to the correct length, a cutting mask is used as a gauge to position the hand-held cutters at the appropriate height above the diode.

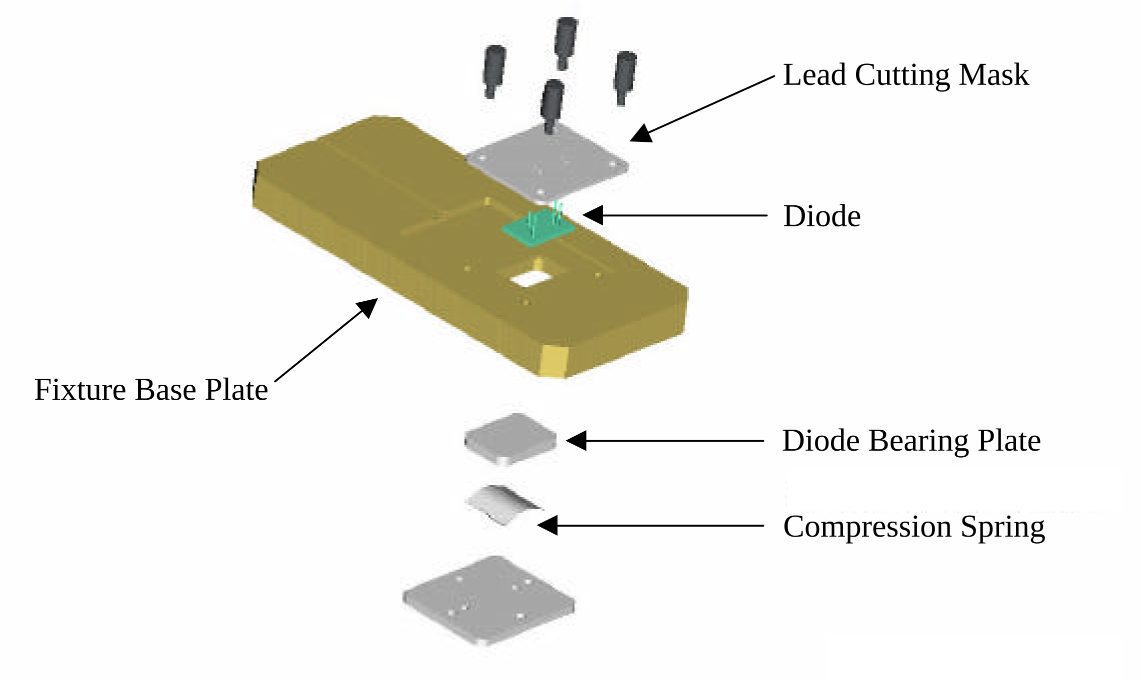


Figure 2: Exploded View of Tooling Configured to Cut PIN Diode Leads

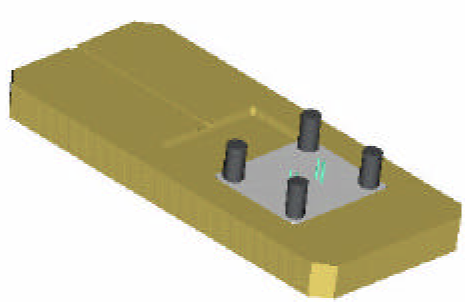


Figure 3: Assembled View of Tooling Configured to Cut PIN Diode Leads

2) **Soldering Mask:** The soldering mask provides two functions during the soldering operation

- Position each of the four tinned wires at the specified radius and height above the diode ceramic carrier, as shown in Figure 1, during soldering operations
- Protect the PIN diode against excessive solder flux flow during soldering cleaning.

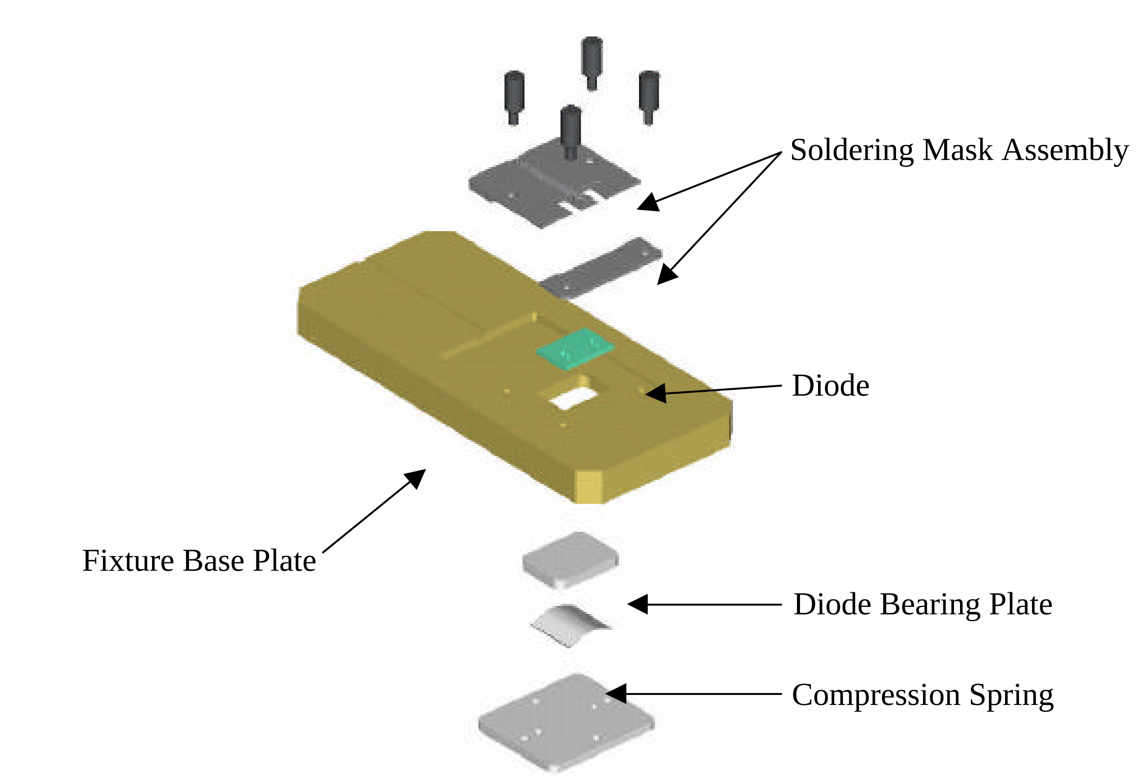


Figure 4: Exploded View of Tooling Configured to Solder PIN Diode Leads

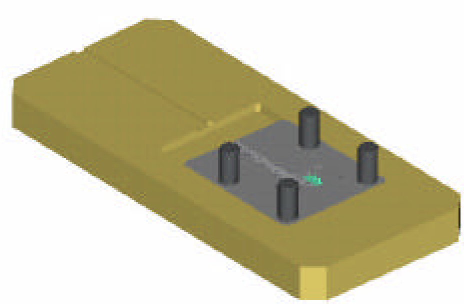


Figure 5: Assembled View of Tooling Configured to Solder PIN Diode Leads

3) **Staking Masks.** The staking mask is used to hold the four electrical wires in the specified configuration and define the volume – both size and height – for the staking material. This masks stays in place throughout the cure of the staking material.

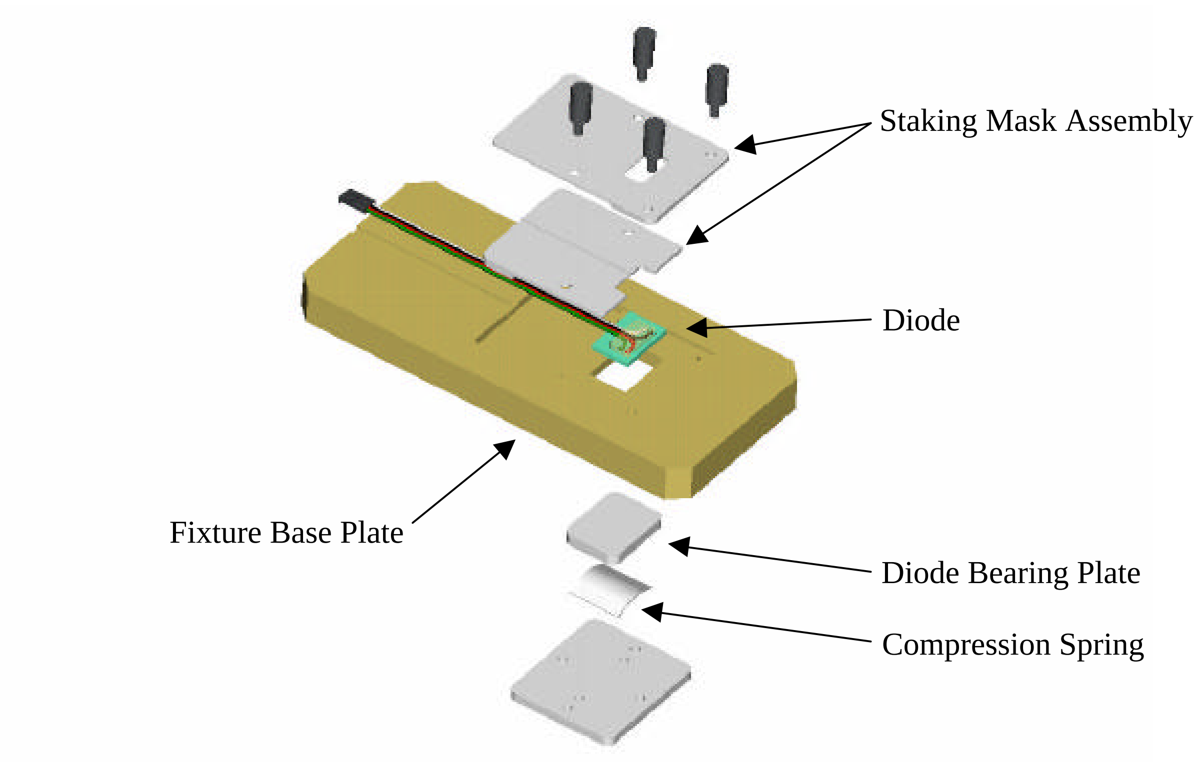


Figure 6: Exploded View of Tooling Configured to Stake PIN Diode Leads

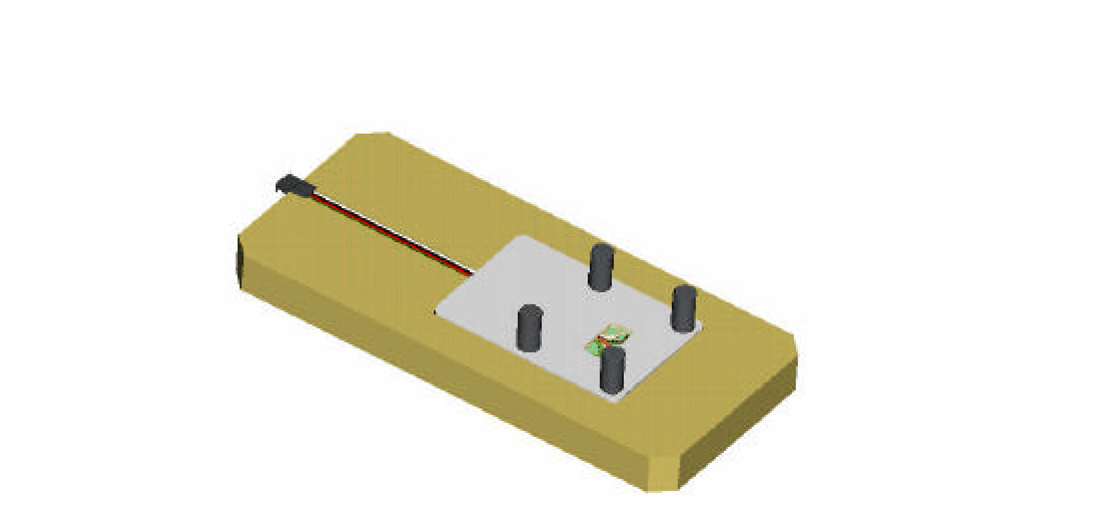


Figure 7: Assembled View of Tooling Configured to Stake PIN Diode Leads

5 QUALITY ASSURANCE

5.1 Inspection And Acceptance Criteria For Solder Joints and Staking

5.1.1 General

The acceptance criteria shall be based on the requirements outlined in NASA-STD-8739.1 and NASA-STD-8739.3 Specifications, which will be the governing documents. Illustrations and photographs in NASA Soldering and Staking documents shall be used to the greatest extent possible in determining acceptance or rejection of soldered connections. Soldering shall be performed in such a manner as to be uniform in quality and free from defects. Inspection shall be performed at 10x magnification to verify workmanship requirements.

The supplier shall perform systematic audits on all activities defined here in for monitoring their own performance to verify the implementation and effectiveness of the provisions defined in the QA program plan.

NRL and its representative shall have the right to be present during the manufacturing inspection and testing. NRL may perform source inspection whenever possible. Traceability of all materials shall be maintained on the travelers/work orders.

The supplier shall have secure storage areas for incoming materials, intermediate items during the process needing temporary storage and exit items before shipping.

5.1.2 Acceptable Solder Connections

Solder connections wire cables and DPD leads will be acceptable when characterized by the following:

1) Clean, smooth, bright, undisturbed surface.
2) Solder fillets between the DPD lead and wire cable conductor are as described and illustrated in NASA-STD-8739.3 soldering standards.
3) Complete wetting.
4) Proper amount and distribution of solder.

5.1.3 Rejectable Solder Connections

Solder connections on wire cable and DPD assemblies will be rejected when any of the following conditions exist:

1) Charred, burned or melted insulation on the wire cable.

2) Discoloration, which is continuous between DPD lead and wire cable conductors.

3) Excessive solder (including peaks, icicles and bridging).
4) Flux residue, solder splatter or other foreign matter on circuitry or adjacent areas.
5) Insufficient solder.
6) Pits, holes or voids, or exposed base metal in the soldered connection.
7) Disturbed solder connection.
8) Fractured or cracked solder connection or evidence of grain structure change.
9) Cut, nicked, gouged or scraped conductors.

5.1.4 Wetting

Wetting is solder that has adhered to both surfaces of a solder connection. Dewetting is defined as a connection where the solder first wets the surfaces, it leaves behind a thin coat of solder over the base metal, then "balls up" on the surface. This condition is usually the result of improper surface treatment and will be rejected.

5.2 Qualification

Personnel, materials and equipment to be used in the process covered by this specification shall be approved and qualified by Quality Assurance prior to production use.

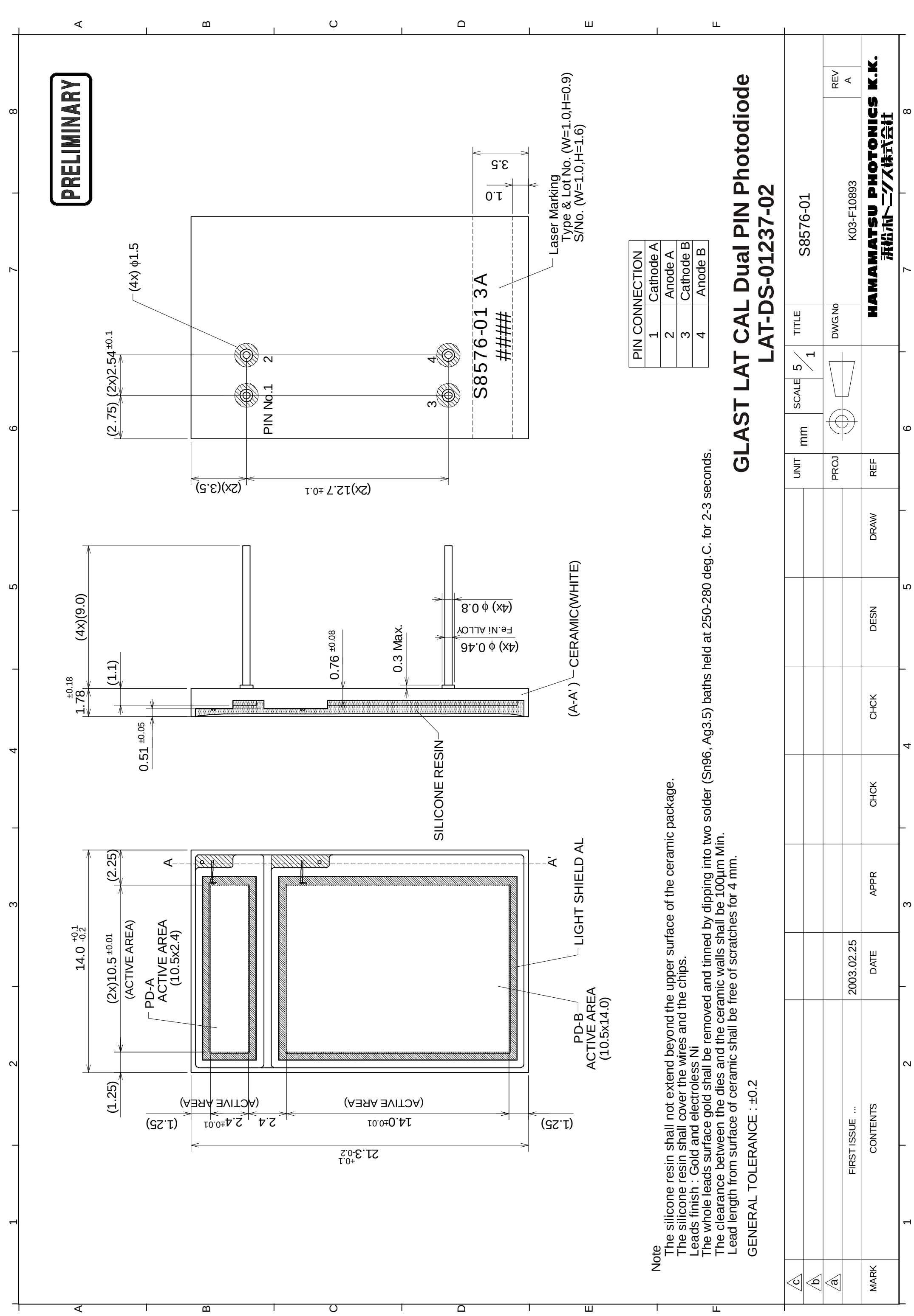
5.3 Process Controls

Maintenance of adequate process controls shall be verified by monitoring quality performance and quality trends. Periodic Quality Assurance audits will assure compliance.

APPENDIX A

Dual PIN Photodiode

The Dual PIN photoDiode (DPD) complies with the specifications and tolerances in the Calorimeter Flight Dual PIN Photodiode Specification, LAT-DS-00209-12.



(This drawing has changed. Use the latest drawing from document LAT-DS-00209-12.)

APPENDIX B

PDA Manufacturing and Process Flow

PDA Manufacturing Flow